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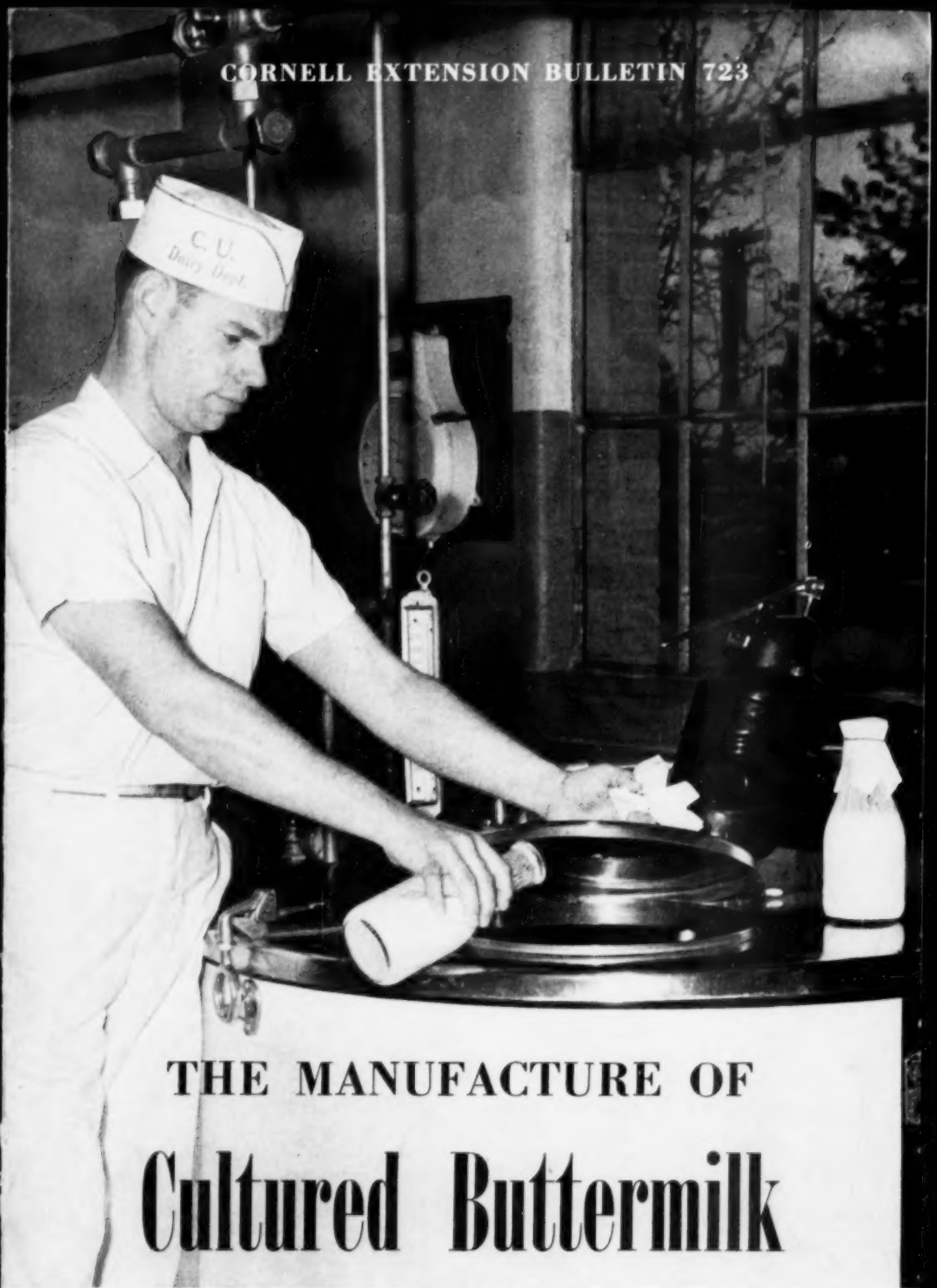

THE MANUFACTURE OF Cultured Buttermilk

BY F. V. KOSIKOWSKI AND E. S. GUTHRIE

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The Manufacture of Cultured Buttermilk

F. V. Kosikowski and E. S. Guthrie

Cultured buttermilk is a skimmed, or partly skimmed, pasteurized milk that has had some of its sugar fermented, by lactic-acid bacteria and related groups, to lactic acid and volatile substances, with the accompanying production of curd and pleasing aroma and flavor. This product sometimes is known as *artificial* or *commercial* buttermilk.

Cultured buttermilk and natural buttermilk in general are almost similar in chemical composition, but bacteriologically the two types may not be much alike. Cultured buttermilk is made by ripening or souring skimmilk with a starter. Natural buttermilk, on the other hand, is the portion of the cream that is left after the butter granules have been collected. It contains the various types of microorganisms of the cream, only a few of which may be the desirable lactic-acid species. The bacteria in natural buttermilk are likely to be undesirable because they may cause defective body and poor flavor. This has, to a great extent, limited the use of "natural" buttermilk as a food in the United States.

The importance of cultured buttermilk from the standpoint of use has never been fully evaluated and consequently not appreciated. This product, however, has been gaining popularity in the United States because of its appetizing qualities. It is nutritious, thirst-quenching, an important aid in cooking, and relatively inexpensive. Economically, the increased consumption of cultured buttermilk would help the entire dairy industry, for it would utilize skimmilk which might otherwise be wasted.

Increased use of such fermented dairy products as cultured buttermilk, cottage cheese, and sour cream, along with all foods, is linked with high quality. The purpose of this bulletin is to tell how to maintain good quality in cultured buttermilk through a simple method of its manufacture, and to discuss some of the more important problems usually encountered in its manufacture.

Regulations

New York State has no regulations regarding the composition of buttermilk. There is, however, a federal regulation concerning its composition. The Food and Drug Administration uses, in an advisory capacity, the following standard which was adopted

under the Food and Drug Act of 1906:

"Cultured Buttermilk. The product obtained by souring pasteurized skimmed or partially skimmed milk by means of a suitable culture of lactic bacteria. It contains not less than 8.5 per cent of milk solids (not) fat."

Steps in Processing Cultured Buttermilk

1. Obtain good starter and good skimmilk.

The first requisite in the manufacture of cultured buttermilk is the propagation of a good starter culture. Instructions for developing this culture can be obtained from commercial bacteriological laboratories or can be found in Cornell Extension Bulletin 179, *Starter for Butter, Cheese, Cultured Cream, and Cultured Buttermilk.*

Skimmilk with a desirable flavor should always be used as a base. Simple quality tests required in the deck inspection of fresh whole milk could be used to good advantage in eliminating poor lots of skimmilk.

2. Pasteurize skimmilk at from 180° to 185°F. for 30 minutes.

A temperature range of from 180° to 185°F. for pasteurization is optimum for the development of proper flavor and body characteristics. To use temperatures higher than 185°F. or to hold the milk for more than 30 minutes at these temperatures is usually a waste of time and energy. The type of pasteurizer to use depends to a great extent upon the volume of buttermilk produced.

3. Cool pasteurized skimmilk to from 70° to 72°F.

Cooling pasteurized skimmilk to 70° to 72°F. should be done as quickly as possible.

4. Inoculate skimmilk properly with correct amount of good starter.

The amount of starter required for a daily inoculation should be from 1.5 to 2.0 per cent or from about 1.0 to 1.5 pints to each 10 gallons of skimmilk. Experience will be the guide. Extreme care should be taken at this point to transfer the starter without contaminating it or the milk.

5. Incubate bacteria at 70°F.

Although lactic-acid bacteria required in the manufacture of cultured buttermilk grow best at about 92°F., lower temperatures are used in making buttermilk because these bacteria will grow faster relative to the growth of many undesirable bacteria that may be present. The most satisfactory incubation temperature under these conditions is 70°F. It is important to keep the temperature constant so that the flavor will be the best and the curd will be smooth and firm. Variations in temperatures during the entire incubation period should not exceed ± 2°F. If the variation is greater than this, a poor product may result.

6. Ripen mixture to proper acidity.

At 70°F. a curd usually will be formed when the titratable acidity, expressed as lactic acid, is about 0.55 per cent. The curd, however, should

never be broken until an acidity of from 0.75 to 0.80 per cent has been developed. The time required to attain this condition ranges from 12 to 16 hours, depending upon various conditions. Measurement of the titratable acidity should become a routine matter. Breaking the curd at the end of from 12 to 16 hours without determining the amount of acid is too uncertain.

7. Cool and agitate curd.

Usually cooling and agitation are started at the same time. Cooling to 50°F. or lower is desirable. Care must be taken to prevent excess agitation during cooling. For this purpose specially designed cooling and agitating equipment, which is now being featured by dairy supply companies, may be used to advantage.

8. Bottle cultured buttermilk.

In small operations, buttermilk is bottled by a hand-operated bottler and capper; in large operations, a commercial sized bottle filler may be used. It is against the law in New York State to bottle buttermilk with a dipper. This is clearly outlined under Regulation 32 of Chapter III of the State Sanitary Code. Bottles should be run at a slower speed than that normally required for whole milk. At present, glass bottles are apparently used in far greater numbers than are paper bottles.

9. Store cultured buttermilk at from 40° to 45°F.

As most of the cultured buttermilk is manufactured by milk dealers, a storage temperature range of from 40° to 45°F. is convenient, and is effective in maintaining quality. Storage in most instances should not exceed 3 days, because whey separation increases markedly after this period even at this low temperature and under optimum manufacturing conditions.

Modifications in Manufacturing Buttermilk

Buttermilk can be modified in many ways to suit the taste of the consumer. Among the more important are the following:

Addition of Cream

Cream is sometimes added to cultured buttermilk to enhance the flavor. This is done usually after the buttermilk has been cooled. The most common concentration employed before World War II was enough to make a 1.5 per cent fat product. This can be accomplished by adding cream that tests from 20 to 40 per cent fat. Much of the cream used for this purpose comes from milk routes as "returns."

Formation of Butter Flakes

Some buttermilk contains butterfat flakes that simulate natural buttermilk. Butter flakes may be produced in various ways. They may be manufactured by churning whole milk or thin cream in a churn either alone or in combination with the cultured skimmilk.

Another way to produce fat flakes is to send a portion of the cultured buttermilk and cream through a specially designed pump. This pump produces a churning action on the mix-

ture which results in the formation of fat flakes.

Although churning methods are the most popular in the production of fat flakes, some manufacturers use the "Vogt" method. In this method melted butter oil at 160°F. is introduced into the buttermilk with a common sterilized spray gun. As the spray of fat hits the cold buttermilk the individual fat droplets solidify and form flakes. In still another method melted fat may be passed through a sieve into the cold buttermilk while it is being vigorously agitated. In any method the flakes should be about the size of a small pinhead, as such flakes do not rise quickly. The butter oil may be highly colored.

Addition of Salt

In many areas salted buttermilk is popular as it brings out the flavor. The optimum amount is about 0.1 per cent. A concentration of 0.25 per cent when tested in the Cornell laboratory was considered too strong by the judges. For best results, salt should be added to the skimmilk just before pasteurization.

Equipment

A pasteurizer, an incubator, a cooling system, and a bottler and capper are needed. The pasteurizer and the incubator are for all practical purposes the same. When small quantities of buttermilk are made, a well-tinned 40-quart milk can partly immersed in a water tank may be employed as a pasteurizer and incubator. When large quantities are made, pasteurizing vats specially designed for buttermilk are employed. Practically all buttermilk is cooled while in the vat or can. In many instances when an extra viscous product is manufactured, special vent tubes with a large vent opening may be used on the bottler. Whenever possible a minimum number of pumps should be used. Gravity flow is the best way to move buttermilk.

All equipment should be made of materials that will not affect the flavor of the product. Stainless steel and glass are among the best.

Washing and Sterilization of Equipment

The proper washing and sterilization of vats, utensils, and pipe lines used in processing buttermilk is essential for high quality. A standard washing procedure is first to rinse all equipment with cold water immediately after use; secondly, to brush it thoroughly with warm water (120°F.) containing a good washing powder; and thirdly, to rinse the equipment with luke-warm water. To sterilize properly, all equipment should remain in contact with 180°F. water for 5 minutes. Usually chlorine or steam sterilization may be used in place of hot water.

Defects in Cultured Buttermilk

Much of the success in the production of high-quality cultured buttermilk depends upon the ability of the individual to recognize flavor and body defects and to take the proper corrective measures. Too often a defect, such as bad flavor or weak body, is

tolerated on the assumption that such characteristics are normal for this product. In many other instances when these defects are recognized as such, a lack of initiative or possibly insufficient training as to their prevention on the part of the operator contributes to the continuation of a poor product. The production of a high-quality product is dependent upon strict daily adherence to following the rules of good sanitation; to maintaining a standard product in terms of body and flavor; and to catering to consumer preference.

Some of the more important defects of cultured buttermilk and some recommended preventive measures are outlined in the following pages. The defects are associated with flavor and with body.

Flavor Defects

Defects associated with flavor are generally the more objectionable, not only because of their adverse effect upon the consumer but also because of their persistent tendency to remain until drastic corrective measures are made.

Lack of excellent flavor

Buttermilk that lacks flavor can usually be detected by its flat insipid flavor. This flatness may be due to the absence of typical flavor-producing organisms in the starter, to poor-quality skimmilk which may have been watered, or to slow-growing starters. Starters contain high-acid-producing organisms, such as *Streptococcus lactis* or *Streptococcus cremoris*, whose function it is to set up an acid curd in the milk, and also flavor-producing organisms, such as *Streptococcus cirtovorous* and *Streptococcus paracitrovorous*, which act upon citric acid in the milk to produce flavor-producing compounds, including acetyl methyl carbinol (acetoin) and diacetyl. If environmental conditions are not conducive to bacterial growth, these organisms may not be present in large enough number to perform their specific functions. For example, if incubation temperatures are maintained at 80°F. instead of 70°F., the flavor-producing organisms will not function properly.

The following precautions are necessary to prevent or to correct flat flavor in cultured buttermilk: A good commercial culture from a reliable firm should be used. High-quality milk should always be used. The concentration of between 0.80 and 0.85 per cent of acid in the finished product is highly desirable. Incubation temperatures that do not vary much beyond 70°F. are necessary. Finally, cream or salt or sodium citrate wherever legal may be added to the buttermilk to give it more flavor.

Putrid, unclean, and bitter flavors

Putrid or putrefactive flavors in cultured buttermilk are produced by the decomposition of milk proteins with the production of highly volatile and offensive compounds such as skatol and indole. This defect is easily recognizable because of the intense putrefactive aroma present, in many instances strongly resembling dirty dishwater, and also because the appearance

of this flavor is usually associated with a very weak and watery body. Bitter flavors are invariable present when putrefaction takes place. Various protein-digesting and gas-producing bacteria are responsible. These bacteria are contaminants and many of them are not destroyed by minimum pasteurization temperatures.

To correct a putrid flavor, it is best to discard the old mother starter and begin with a new commercial culture. At the same time added precautions should be observed in sterilizing the equipment and in handling the milk which should be of excellent quality. Pasteurization of the skimmilk at 180° to 185°F. for 30 minutes is also an essential step. After the milk has curdled, it should be cooled to 50°F. and stored at approximately 40° to 45°F.

Excess acid or sharp acid flavor

In cultured buttermilk, lactose or milk sugar is acted upon by lactic-acid bacteria and broken down mainly to lactic acid. After the milk has been curdled, this acid production still continues; if it becomes excessive, a sharp or stinging sensation is produced in the mouth when the cultured buttermilk is tasted. Normally, milk after being curdled at 70°F. has an acidity expressed as lactic acid of 0.55 to 0.60 per cent. Later, as the organisms continue to work, this concentration of acid, expressed as lactic, may go to 1.0 per cent. If the acid ranges much above 0.85 per cent, the prickly or sharp sensation will appear. In some localities, however, excess acid may not be considered a defect as consumers have become accustomed to it through long use of this type of buttermilk.

To prevent excess acid flavor, a smaller inoculation of starter should be added to the skimmilk and at the same time the acidity of the buttermilk just after curd formation should be determined. An acidity of 0.75 to 0.80 per cent is generally considered optimum at the time of curd breaking, but quick cooling of the product to 50°F. is needed to check further rapid increase in the production of acid. If the acidity is beyond 0.85 per cent, salt may be added to cut the sharpness. A salt concentration of 0.1 per cent is optimum and the maximum should be 0.2 per cent.

Metallic flavor

Metallic flavor is characterized by a puckery feeling on the tip of the tongue after tasting. It may result from excessive copper contamination from processing vats and pipe lines and is especially prevalent under these conditions when there is excess acid ($>$ 0.85 per cent) in the buttermilk.

This defect may be largely prevented by using glass or stainless steel equipment. If, however, the product can be made only in copper equipment, the acid should be carefully controlled to prevent excess concentration and the buttermilk removed from the equipment as soon as possible. Also, if chlorine sterilizers are being used and if this defect still persists after the application of other preventive measures, then chlorine steri-

lization should be discontinued and hot-water or steam sterilization should be substituted.

Body Defects

Wheying-off, or whey separation

The water content of normal milk is about 87 per cent; skimmilk contains slightly more. When the milk curdles in the manufacture of cultured buttermilk, this water still remains but it may be completely held by the protein as a sponge holds water, or part of it may be expelled from the protein and appear as a watery layer. This watery-layer condition is called *wheying-off* or *whey separation*, and the free liquid is called *whey*. Actually, whey is not pure water as it contains soluble minerals, proteins, lactose, and vitamins.

Under normal circumstances free whey in buttermilk does nothing to detract from its nutritive properties, but its unsightly natures makes it objectionable from an esthetic point of view. Also, as some wheying-off is a result of bacterial decomposition, this defect may be associated with putrefactive or bitter flavor in the buttermilk.

In many buttermilks, whey separation is caused not by bacterial decomposition of the proteins but by improper processing methods that provide optimum conditions for the expulsion of whey from the protein. Generally this type of whey separation is detected by the fact that all the whey is at the top of the buttermilk container, whereas free whey produced as a result of bacterial action is usually

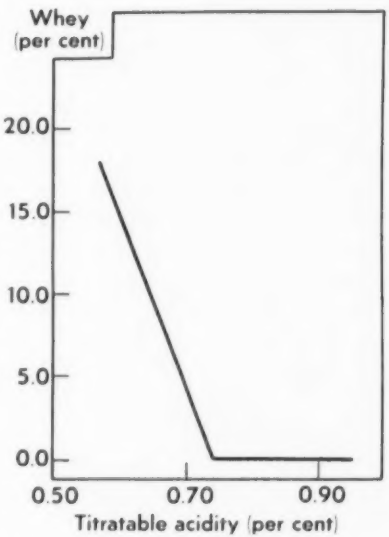

Figure 1. Relationship between titratable acidity and percentage of whey in cultured buttermilk.

either at the bottom of the container or distributed in pockets throughout the body of the buttermilk. Manufacturing practices that tend to encourage wheying-off include improper acidity control, low pasteurization temperatures, violent agitation, and long storage at high temperatures.

It has been assumed for many years that high acidity contributes greatly to wheying- off. Actually this is not true, for as the acidity of the buttermilk increases the amount of whey decreases as shown by Kosikowski and Brueckner[1] in figure 1. At the low temperatures at which buttermilks are held there is a greater tendency to retain

[1]Kosikowsky, F. V., and Brueckner, H. J. A Study of Factors Influencing the Quality of Cultured Skimmilk or Buttermilk. Milk Dealer, August, 1941.

more of the whey in the curd of higher acidity. At low acidities of curd breaking, however, there is a far greater chance for whey separation. If the buttermilk curd is broken at an acidity (expressed as lactic) of from 0.60 to 0.75 per cent, there is a good chance for wheying-off, whereas wheying-off is much less likely to happen if the curd is above an acidity of 0.75 per cent when broken. This is more clearly illustrated in figure 1. It should be apparent when reading this figure that a watery curd is low in viscosity and that the ideal body is distinctly higher in viscosity.

Pasteurization temperatures of 145° to 165°F. for 30 minutes greatly increase the possibility of wheying-off, whereas temperatures ranging from 165° to 210°F. for 30 minutes decrease this tendency. A temperature of 180° to 185°F. is considered optimum from the standpoint of minimizing free whey.

Violent and too long agitation of buttermilk during cooling increases free whey considerably. It is difficult, however, to recommend a correct agitation force and time, as conditions under which buttermilk is agitated vary widely. If whey separation is a problem, the type of agitation should be investigated; if it seems that agitation may be a source of the trouble, then either less force or less time of agitation, or both, should be instituted.

Incubation temperatures also must be controlled so that they will remain fairly constant, for at high incubation temperatures (about 80°F.) whey separation is more likely to occur.

Churning of buttermilk will also increase free whey.

It has been pointed out that bacterial contamination may bring about wheying-off. This can be controlled by using the same corrective practices as those recommended for the prevention of putrid flavors (page 7).

The use of gelatin or fat has been recommended as a way to prevent the appearance of free whey. Gelatin, however, is used relatively little, even though much is heard about its merits.

Viscosity Defects

Too much viscosity

Many cultured buttermilks are so thick that they appear more like custards than fluids, and in this condition it becomes difficult to empty the container. This lack of fluidity also appears to decrease the refreshing qualities of buttermilk. The most important condition involved in this defect is high acidity. As the acidity goes up, the buttermilk becomes thicker in body. This is graphically illustrated in figure 2 from information obtained by Kosikowski and Brueckner.[2] Not enough agitation during cooling and extremely low storage temperatures also increase viscosity. Certain strains of *Streptococcus lactis* may produce a viscous product. Also, contaminating types of bacteria may produce ropy or slimy milk which in turn increases viscosity. Another condition that influences viscosity is high solids-not-fat,

[2]Kositkowsky, F. V., and Brueckner, H. J. A Study of the Factors Influencing the Quality of Cultured Skimmilk or Buttermilk. Milk Dealer, August, 1941.

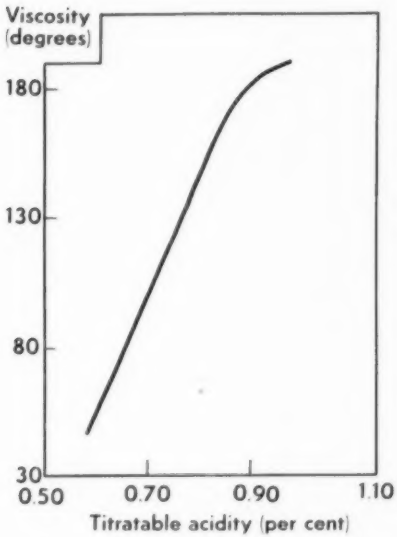

Figure 2. Relationship between titratable acidity and viscosity in degree of retardation of cultured buttermilk.

as any increase in solids in buttermilk usually results in greater viscosity.

To correct a highly viscous body in buttermilk, the acidity at the time of breaking the curd should be from 0.75 to 0.80 per cent and should not subsequently be allowed to go higher than 0.85 per cent if possible. The milk should have an average solids-not-fat content of about 9.0 per cent, and agitation should be increased. In addition, viscous strains of bacteria should not be present. To do this, the culture, if it contains viscous strains, should be changed and rules of good sanitation in sterilizing the equipment and handling the milk should be followed.

Too little viscosity

A thin-bodied buttermilk is almost as objectionable as a thick-bodied buttermilk. This defect is associated with too low an acidity at the time of breaking the curd; low solids-not-fat in milk; excess agitation; high storage temperatures; and presence of protein-digesting bacteria. Corrective measures would include breaking the curd at higher acidity (0.75 to 0.80 per cent); using less agitation; storing at below 45°F.; building up solids-not-fat; and eliminating protein-digesting bacteria by changing the mother starter or by using better sterilizing techniques. In some instances, gelatin and fat have been added to increase the viscosity of the product.

Air in buttermilk (foamy buttermilk)

When bottles of buttermilk delivered to the consumer are not full, the source of the trouble usually can be traced to excess air incorporation in the product during processing. Incorporation of air may be caused by leaks in suction ends of pumps; unfilled pipe lines; and defective bottle fillers. Occasionally when buttermilk is dropped a considerable height, as from one floor to another, this defect will be present. Also, contributing to the incorporation of air in buttermilk is severe agitation or improper agitation. Some agitators are built to incorporate excessive air in the mixture, but recent developments have produced agitators that keep air incorporation to a minimum.

Standardization and the Acidity Test

In the manufacture of buttermilk, one of the most important steps usually overlooked is the standardization of the product. The firm with a name for high quality invariably puts out a standard product. One of the best ways to standardize buttermilk, and one overlooked by a good many dairy operators, is the use of the simple acidity test. The acidity of buttermilk is directly or indirectly connected with more defects than any other factor. Acidity control should be employed every time buttermilk is made. The most critical point for its use is just before the curd is agitated. Many operators agitate a curd as soon as it forms without testing the amount of acidity. This is a highly inaccurate and undependable practice as the concentration of acid here determines to a great extent the final body characteristics of the buttermilk.

The Acidity Test for Cultured Buttermilk

Before the curd is broken, insert a 9-gram pipette and withdraw a sample. If the curd contains appreciatble fat, be sure to obtain a representative sample.

If a torsion balance is available, weigh 9 grams into a small beaker or white cup. If no balance is available, measure 9 milliliters of the material into the container.[a]

Add 5 drops of phenolphthalein indicator (1 gram phenolphthalein + 50 milliliters ethyl alcohol + 50 milliliters water).

Titrate with N/10 sodium hydroxide, while stirring constantly, until a definite permanent pink color is attained.

With 9 grams of buttermilk, to read the per cent acidity, move the decimal point one place to the left of the original titration value. For example: if 7.0 milliliters of N/10 sodium hydroxide has been used for 9 grams, the percentage of titratable acidity in the buttermilk is 0.70 per cent.

[a]If neither the torsion balance nor the 9-milliliter pipette is at hand, you may use a 17.6-milliliter pipette to measure the sample. As this pipeette will deliver approximately 18 grams (twice the normal sample), the necessary amount of neutralizing agent will be doubled; the resulting figure, therefore, must be divided by 2. For example, if 15 milliliters of N/10 sodium hydroxide were used, setting the decimal point one place to the left would yield 1.5; and dividing this figure by 2 would show an acidity of 0.75 per cent (1.5 ÷ 26p=0.75).

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